# Challenges with developing a Commercial P2P System

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# Outline

- Why P2P?

- RN Content Delivery Profiles

- Design Challenges for a Commercial P2P System

- Insights from our P2P Bandwidth Savings Study

- Future Research Directions

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# Why P2P?

- Economical, scalable content delivery
  - Reduction in bandwidth costs and server capacity
    - BitTorrent claims of 80+% savings are hard to ignore.
  - Availability increases with popularity -> no overprovisioning for flash crowds.
    - Large-scale events require us to maintain large server farms for events that only happen a few times a year.

# Content Delivery Profiles

- Have several different delivery profiles to address

    - On-demand music service (Rhapsody)

        - Millions of clips

        - Typically 3-7 minutes, ~4-6 MB each

    - Large Live Broadcast events (Real Broadcast Network)

        - Big Brother

        - Sub-10 second latency, w/ 10s of thousands of users.

    - Movie & Casual Game Downloads (Film.com, RealArcade)

        - 10-100s of MB

        - 100-1000s of titles.

# Challenges for P2P networks

- NAT Traversal

- Content Integrity

- System Security

- Churn

- Fairness

- Peer Heterogeneity

- Quality of Service

- Participation Incentives

# Legal vs Illegal Content Challenges

- Illegal Content
  - Best effort service acceptable.
  - Don't expect QoS guarantees.
  - No financial investment in content.
  - Willing to take chances with potentially malicious software to gain access to the content.

- Legal  Content
  - Expect a base level of QoS.
  - Content must always be available, esp. if they are paying money.
  - Customers wary of "unnecessary connections" from commercial products. Acceptance requires consumer education & incentives.
  - Content & delivery network must be secured to keep rights holders happy.

# Where do we start?

- Focus on subset of the challenges that capture important aspects of our various delivery profiles.

  - Churn

  - Peer Heterogeneity

  - Quality of Service

- Determine how these challenges affect BW savings in a peer assisted CDN

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# P2P Bandwidth Savings Study

- Study BitTorrent to understand potential BW savings for RN workloads.

- Explore dimensions that likely affect BW savings

  - Peer BW heterogeneity

  - Arrival/Departure processes

  - Seeding Strategies

- Determine whether BW saving are worth the effort of developing a P2P delivery system.
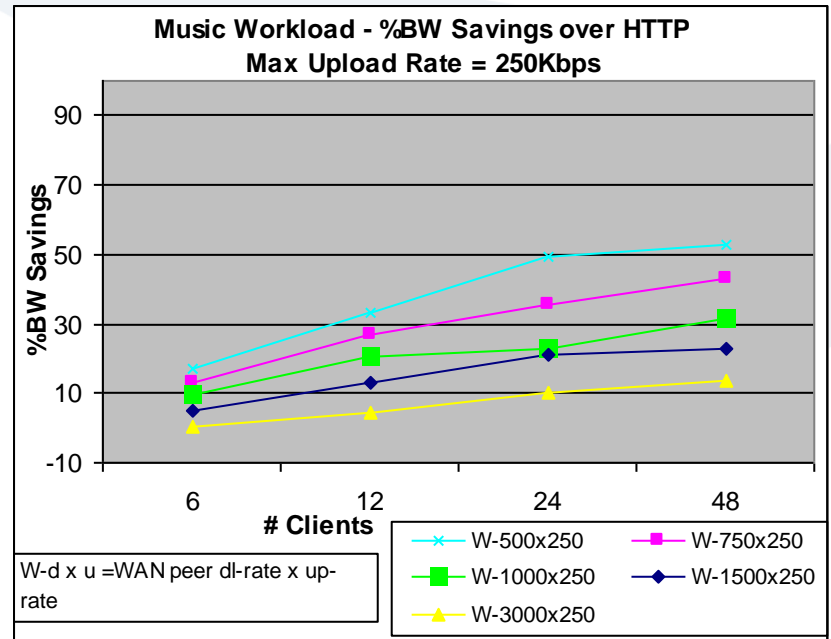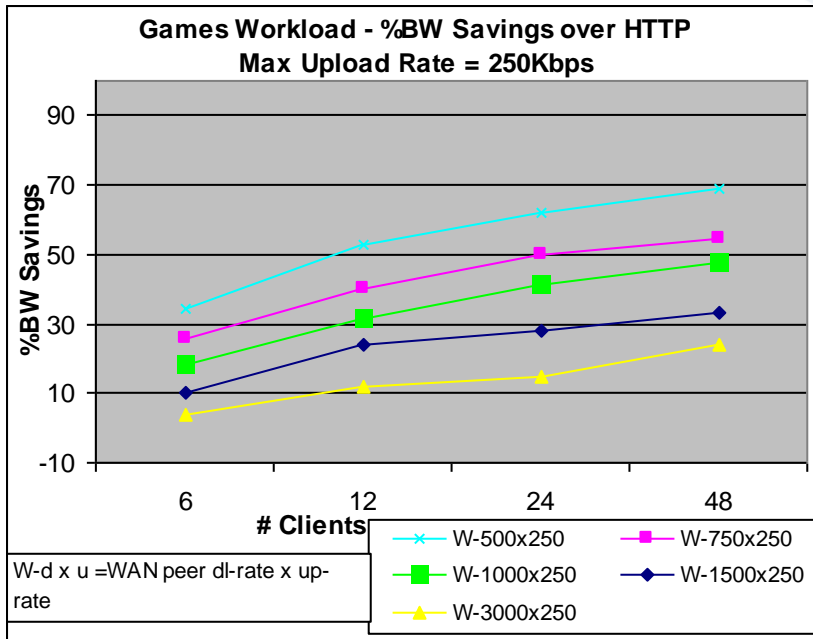
# Evaluation Environment
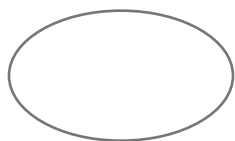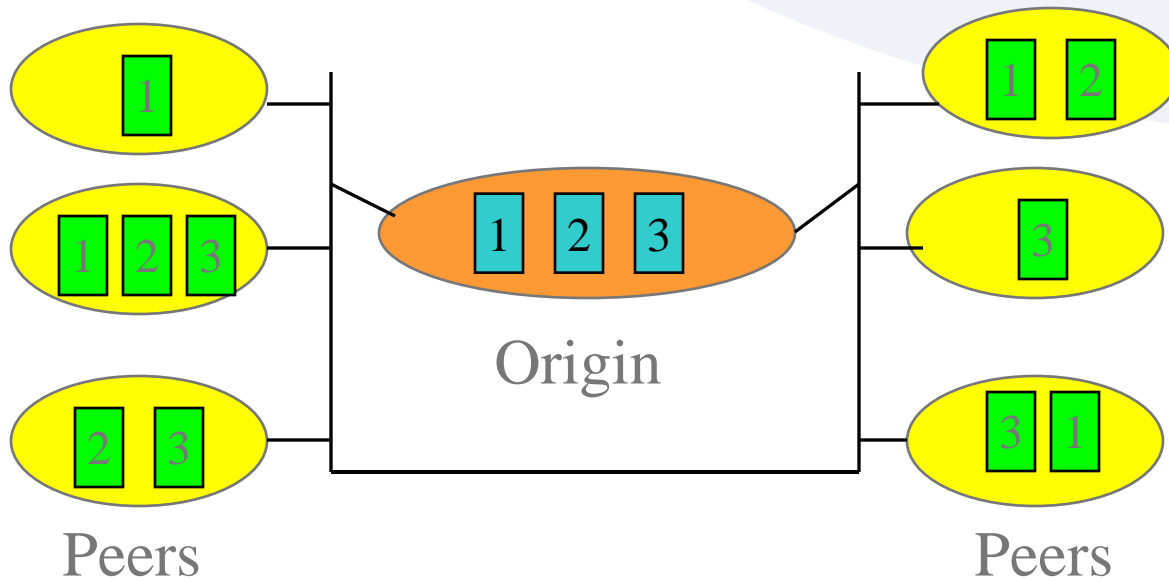
# WARNING

Graphs are intended to display trends and provide intuition about behavior.

The data is preliminary and should not be taken as actual BW savings.

# BW Savings- Impact of peer UL/DL ratio



Games Workload - %BW Savings over HTTP
Max Upload Rate = 250Kbps

Music Workload - %BW Savings over HTTP
Max Upload Rate = 250Kbps
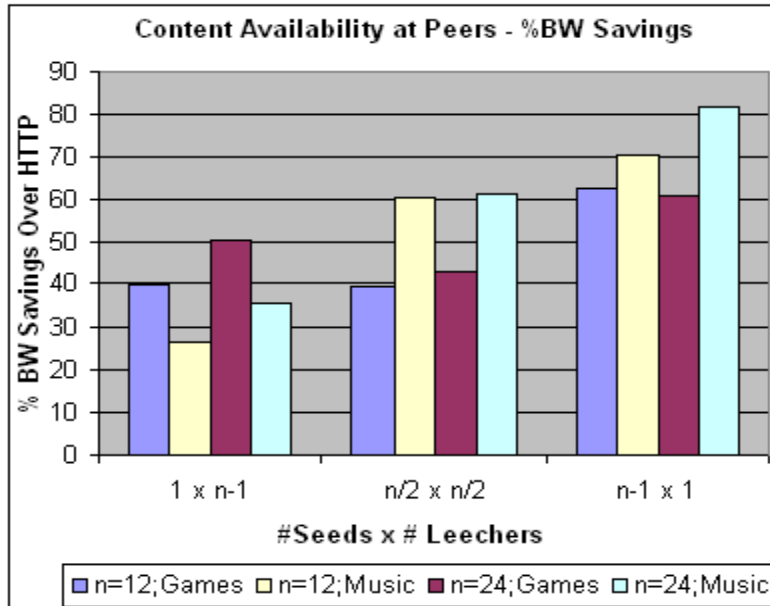
- For fixed UL rate, as DL rate ↓, BW savings ↑
  - Lower DL rate → longer transfers & fewer peers to saturate link → more data from peers instead of origin
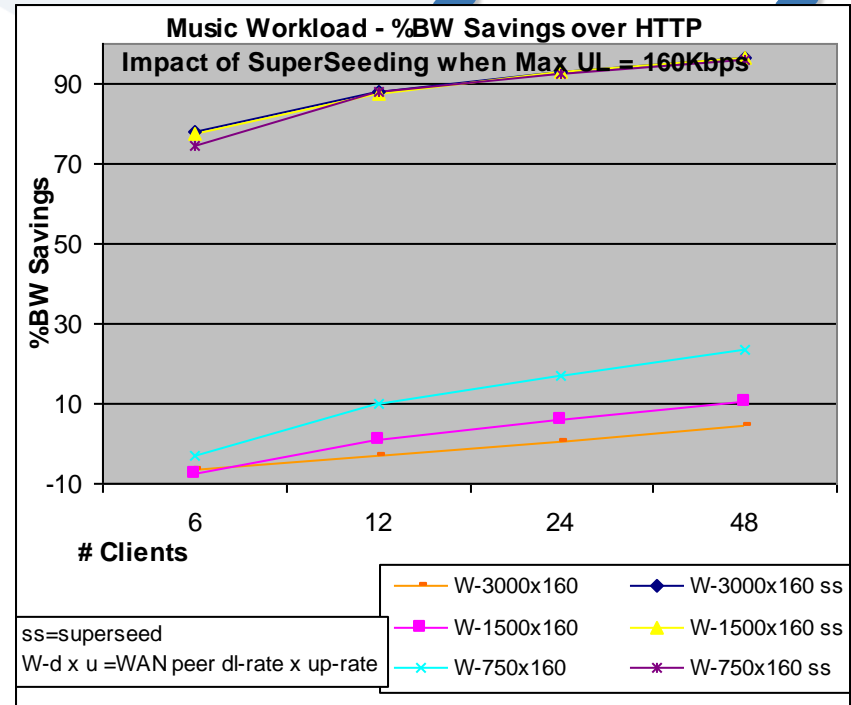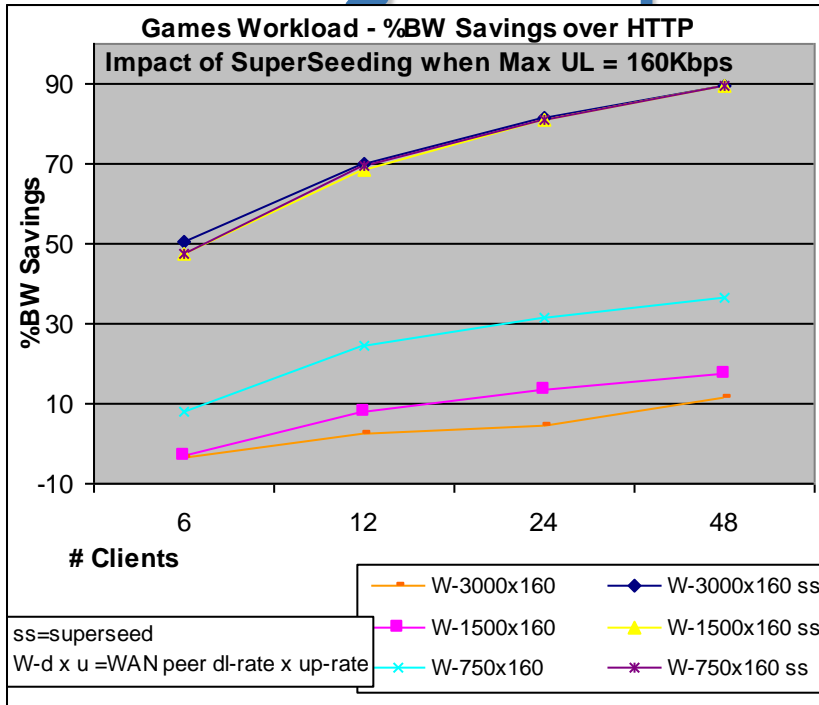
# Impact of Content Availability at Peers*



Content Availability at Peers - %BW Savings



Content Availability at Peers - Avg DL Rate
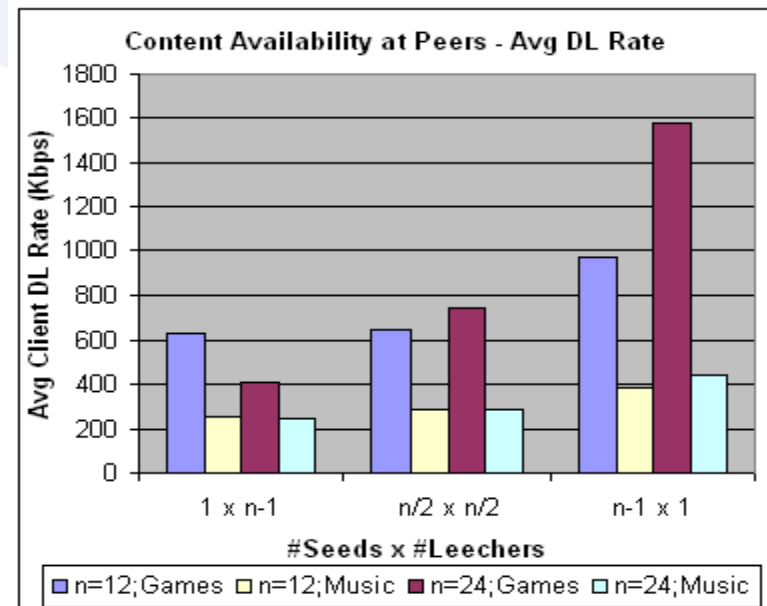
- Content availability at peers influenced by peer seed time and file inter-reference time

  - Both factors can be captured by #Seeds:#Leechers

- BitTorrent tends to favor downloading from seeds

  - Previous results used 1 seed and n –1 leechers  (i.e., 'worst' case)

- More seeds → better availability → more BW savings

  - Provide incentives to seed (inherent for live content)

* Max UL rate = 250 Kbps Max DL rate = 750 Kbps

# BW Savings - Impact of seeding strategies



**Games Workload - %BW Savings over HTTP**
Impact of SuperSeeding when Max UL = 160Kbps

%BW Savings vs # Clients (6, 12, 24, 48)

ss=superseed
W-d x u =WAN peer dl-rate x up-rate

Legend:
- W-3000x160
- W-3000x160 ss
- W-1500x160
- W-1500x160 ss
- W-750x160
- W-750x160 ss

**Music Workload - %BW Savings over HTTP**
Impact of SuperSeeding when Max UL = 160Kbps

%BW Savings vs # Clients (6, 12, 24, 48)

ss=superseed
W-d x u =WAN peer dl-rate x up-rate

Legend:
- W-3000x160
- W-3000x160 ss
- W-1500x160
- W-1500x160 ss
- W-750x160
- W-750x160 ss

- "Smarter" seeding to minimize BW utilization at origin
  - SuperSeeding mode (origin masquerades as leecher)
  - Explicitly cap upload rate at origin
- Significant savings in BW w/ superseeding
- But …

# Mean DL rates w/ SuperSeeding
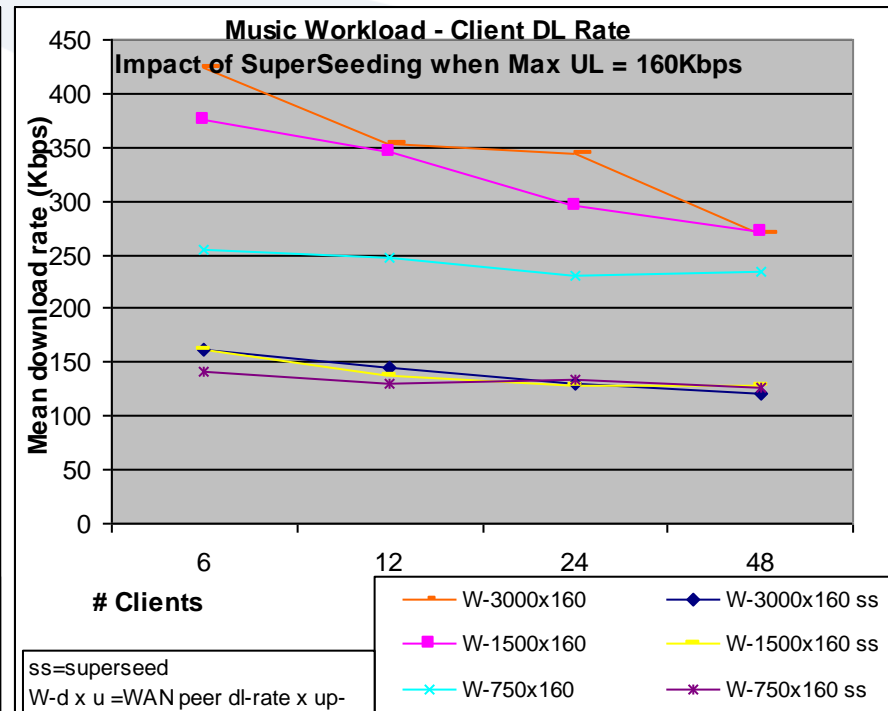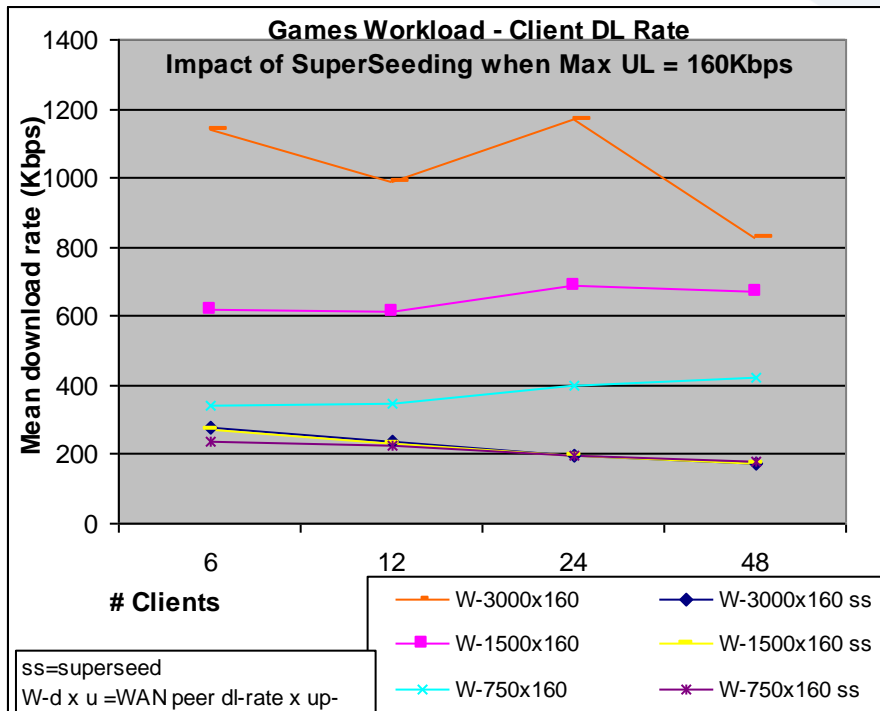


- Mean DL rate at clients significantly lower w/ superseeding
  - Often < file encoding rate (e.g., <150 Kbps for music)
- Origin cannot attempt to reduce BW too aggressively if QoS matters

# Study Conclusions

- Significant savings can be realized for a variety of workloads.

- Peer BW, mesh composition, and seeding strategy have complex interactions that vastly affect bandwidth savings.

- Key parameters need to be identified to help control BW savings.

# Future Research Directions

- Further explore the parameter space covered in the study.

- Study how fairness, security, resource utilization, etc. affect BW savings.

# Questions